PCT WORLD INTELLECTUAL PROPERTY ORGANIZATION
International Bureau

INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(51) International Patent Classification 6 : F23R 3/10, 3/50, 3/54	A1	(11) International Publication Number: **WO 99/61840** (43) International Publication Date: 2 December 1999 (02.12.99)

(21) International Application Number: PCT/SE99/00862

(22) International Filing Date: 20 May 1999 (20.05.99)

(30) Priority Data:
9801818-7 25 May 1998 (25.05.98) SE

(71) Applicant *(for all designated States except US)*: ABB AB [SE/SE]; S-721 83 Västerås (SE).

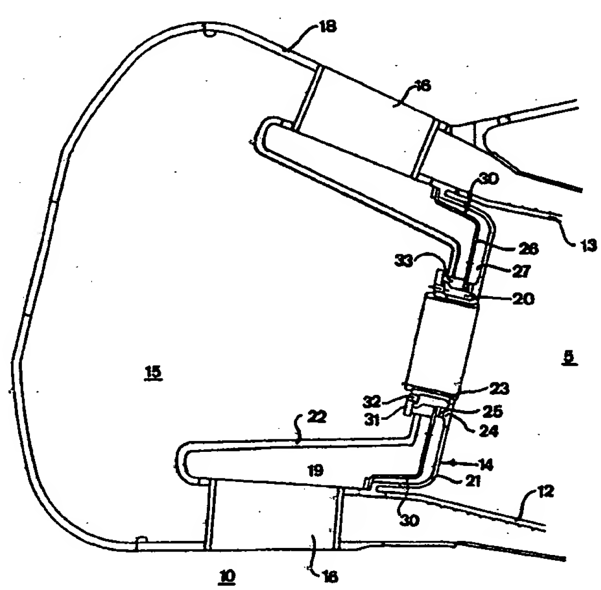
(72) Inventors; and
(75) Inventors/Applicants *(for US only)*: INKER, Mark [GB/GB]; Greystones, The Slad, Grovesend, S. Glos BS35 2TW (GB). ANDERSSON, Leif [SE/SE]; Rapsvägen 2, S-612 38 Finspång (SE). STRAND, Torsten [SE/SE]; Sundsvägen 35, S-612 32 Finspång (SE). NILSSON, Ulf [SE/SE]; Östermalmsvägen 30 C, S-612 42 Finspång (SE). STENFORS, Svante [SE/SE]; Risinge, S-612 92 Finspång (SE).

(74) Agents: BERGLUND, Stefan et al.; Bjerkéns Patentbyrå KB, Östermalmsgatan 58, S-114 50 Stockhlom (SE).

(81) Designated States: AL, AM, AT, AT (Utility model), AU, AZ, BA, BB, BG, BR, BY, CA, CH, CN, CU, CZ, CZ (Utility model), DE, DE (Utility model), DK, DK (Utility model), EE, EE (Utility model), ES, FI, FI (Utility model), GB, GE, GH, GM, HR, HU, ID, IL, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MD, MG, MK, MN, MW, MX, NO, NZ, PL, PT, RO, RU, SD, SE, SG, SI, SK, SK (Utility model), SL, TJ, TM, TR, TT, UA, UG, US, UZ, VN, YU, ZW, ARIPO patent (GH, GM, KE, LS, MW, SD, SL, SZ, UG, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GW, ML, MR, NE, SN, TD, TG).

Published
With international search report.
Before the expiration of the time limit for amending the claims and to be republished in the event of the receipt of amendments.
In English translation (filed in Swedish).

(54) Title: COMBUSTION CHAMBER FOR GAS TURBINE



(57) Abstract

A combustion chamber device for a gas turbine comprises a wall member (11) which defines a combustion chamber (5) having an inlet and an outlet end, wherein the wall member (11) comprises an inlet end portion (14), which has at least one opening (7) for receiving a burner member (6), comprised to generate a flame in the combustion chamber (5) and means (16, 17, 19, 39) for conveying a cooling fluid outside the combustion chamber to the inlet end portion (14) of the wall member (11) for cooling thereof. The inlet end portion (14) is substantially closed and defines a barrier against penetration of the cooling fluid into the combustion chamber (5).

COMBUSTION CHAMBER FOR GAS TURBINE.

THE BACKGROUND OF THE INVENTION AND PRIOR ART

The present invention refers to a combustion chamber device for a gas turbine, comprising a wall member which defines a combustion chamber having an inlet end and an outlet end, wherein the wall member comprises an inlet end portion which has at least one opening for receiving a burner member, arranged to generate a flame in the combustion chamber, and means for conveying a cooling fluid outside the combustion chamber to the inlet end portion of the wall member for cooling thereof.

Conventional gas turbine plants comprises normally a compressor arranged to deliver compressor air to a burner which in turn is arranged to generate a flame in the combustion chamber. In order to cool a combustion chamber wall, and in particular the inlet end portion thereof, the latter is normally provided with a number of holes in order to supply directly via the holes a part of the compressor air to the combustion chamber in such a manner that a layer of compressor air is formed on the inner side of the inlet end portion, whereby a so-called film cooling is obtained.

In order to obtain a high efficiency of a gas turbine a high temperature is required, in accordance with the Carnot-process, at the inlet of the turbine, and more precisely at the first turbine rotor blade. However, high temperatures at the combustion leads to high concentrations of emissions of nitrogen oxides, NO_x, which preferably are avoided in order to fulfil the environmental requirements of today with respect

to combustion plants. Although the average combustion temperature is relatively moderate, local temperature peaks in the combustion chamber may result in high concentration of NO_x in the combustion gases exiting the gas turbine. In connection with the construction of the combustion chamber of a gas turbine, it is consequently aimed at an as low flame temperature as possible and an as high turbine inlet temperature as possible. By the film cooling mentioned above relatively cold compressor air will however be supplied to the combustion chamber and not only cool the combustion chamber wall at said inlet end portion but also the combustion gases formed. Thereby, a raised flame temperature is required in order to maintain a predetermined temperature of the combustion gases. This means that the NO_x concentration will increase or that the turbine process efficiency will decrease if the NO_x concentrations are to be kept on a prescribed level.

SUMMARY OF THE INVENTION

An object of the present invention is to provide a combustion chamber device which enable a combustion with relatively low NO_x concentrations and a relatively high efficiency of a gas turbine run by the combustion gases from said combustion.

This object is obtained by the combustion chamber device initially defined, which is characterized in that the inlet end portion is substantially closed and defines a barrier against penetration by the cooling fluid into the combustion chamber except through the burner member. Since the cooling fluid may not be introduced directly into the combustion chamber the maintenance of a relatively uniform flame temperature of the combustion is promoted, which is favourable since relatively high local temperature peaks of the flame leads to high NO_x emissions. Thanks to the closed inlet end

portion the temperature difference between the flame proper and the combustion gases which reaches a following, first turbine stage or rotor blade wheel of the gas turbine is reduced in comparison with the case when the combustion chamber device, according to previous technique, uses film cooling at the inner side of the inlet end portion.

According to a preferred embodiment, the combustion chamber has a substantially annular shape and is arranged to extend around a rotary axis of a rotor of said gas turbine. Thereby, one single combustion chamber may replace the plurality of separate combustion chambers which according to the conventional prior art are provided around the rotor axis upstream the first turbine stage. By one single combustion chamber, the total wall surface of the combustion chamber may be reduced in comparison with the total wall surface given by several separate combustion chambers. This means that the wall surface to be cooled may be reduced substantially. The part of the inlet end portion of the total wall surface will thereby increase, which means that it is even more important to perform a cooling in such a manner that it has no negative influence on the heat conditions within the combustion chamber. Thereby, the wall member comprises a first, inner wall which is arranged to extend around the rotary axis, and a second, outer wall portion which is arranged to extend around the rotary axis, wherein the inlet end portion defines an annular wall portion extending around the rotary axis and connecting the first and second wall portions.

According to a further preferred embodiment, the combustion chamber device comprises a space for collecting gas to be supplied to the burner member, and a channel arranged to convey the cooling fluid to be used for cooling of the inlet end portion to said space. Preferably, essentially all cooling fluid to be used for the cooling of the inlet end por-

tion is conveyed via the channel to the collecting space. Since the cooling fluid preferably is comprised by compressor air which may and should be used by the burner member for the generation of the flame, this embodiment results in a more efficient utilisation of said compressor air.

According to a further preferred embodiment, the combustion chamber device comprises a member which together with an outer surface of the inlet end portion defines a gap, into which cooling fluid is conveyed for cooling the inlet end portion and from which the cooling fluid is conveyed via said channel, wherein the member comprises a sheet, provided substantially opposite to and in parallel with the outer surface of the inlet end portion to be cooled by the cooling fluid. The sheet has a plurality of holes, arranged to convey the cooling fluid through the sheet, in a direction towards the outer surface of the inlet end portion to be cooled by the cooling fluid. This feature means that so-called impingement cooling may be obtained at the inlet end portion. Thereby, a large number of "jets" of the cooling fluid is directed in such a manner that they hit the outer surface of the inlet end portion at a substantially right angle. Practically this provision has proved to permit a relatively small occupation of space while fulfilling the requirements of cooling efficiency.

According to a further preferred embodiment the combustion chamber device comprises a plurality of burner members and the inlet end portion comprises a plurality of openings, which are distributed around the rotary axis and which each is arranged to receive a respective burner member. Due to the fact that the burner members are provided in this manner at a plurality of location in the annular inlet end portion, it is of an evident importance that the inventive provision of the combustion chamber device results in an efficient

cooling of the inlet end portion along substantially the whole extension thereof.

According to a further preferred embodiment, the inlet end portion comprises a metal sheet which is covered by a ceramic layer on the side which faces the combustion chamber. Thereby, a high temperature resistance of the inlet end portion is obtained, whereby the cooling need is somewhat reduced. In addition, a longer operation lifetime of the inlet end portion may thereby be obtained, and the need for cooling of the side facing the combustion chamber is reduced or eliminated.

Further advantages and features of the combustion chamber device according to the invention will appear from the following description and from the further independent claims.

BRIEF DESCRIPTION OF THE DRAWINGS

The present invention is now to be explained by means of an embodiment described by way of example and with reference to the drawings attached, in which

Fig 1	discloses schematically a sectional view through a gas turbine plant having a combustion chamber device according to the invention,
Fig 2	discloses in more detail a cross-sectional view of a part of the combustion chamber device,
Fig 3	discloses a section of an annular sheet provided with holes for directing a cooling medium towards a inlet end portion, which is disclosed in Fig 2 and 4, and
Fig 4	discloses an alternative embodiment of a part of the combustion chamber device.

DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS

A gas turbine arrangement 1, which appears from Fig 1, comprises a compressor 2 and a gas turbine 3, here solely called turbine. In addition, it comprises a combustion chamber device 4 of an annular type, i.e. a combustion chamber device, the combustion chamber 5 of which extends as a ring and forms a torus around a rotary axis x of the gas turbine arrangement 1.

Furthermore, the combustion chamber device 4 comprises a plurality of burner members 6, arranged to provide a combustion in the combustion chamber 5 for generating a hot gas therein. The burner members 6 thereby project via openings 7 into the combustion chamber 5. Via an outlet opening 8 of the combustion chamber 5, the hot gas is conveyed further to the turbine 3 and brings a rotor 9 thereof to rotate.

A compressor 2 is arranged to deliver a compressor medium, in this case compressed air, to the combustion chamber device 4, and more precisely to the burner members 5, which use the compressor air for their combustion function. The combustion chamber device 4 thereby comprises a space 10, which receives the compressor medium and surrounds the combustion chamber 5, or more precisely a wall member 11 enclosing and defining the combustion chamber 5. The wall member 11 comprises in its turn a radially inner wall portion 12, a radially outer wall portion 13 and an inlet end portion 14, which connects the inner wall portion 12 and the outer wall portion 13 and in which the openings 7 for the burner members 6 are provided.

In addition to the inlet openings 7 and the outlet opening 8, the combustion chamber 5 is substantially completely

closed, i.e. there are essentially no holes or openings in the different portion 12, 13, 14 of the wall member 11. Substantially all of the compressor medium, which is conveyed into the space 10 and contributes to the cooling of the wall member 11, is conveyed further to the burner member 6 and contributes to the achievements of the flames generated by the burner members 6 in the combustion chamber 5. Before the compressor medium, used for cooling purposes, is conveyed into the burner member 6 it is collected in a space 15 enclosing at least a part of the burner member 6 and being connected to the wall member 11.

According to the invention, the inlet end portion 14 is cooled by means of a cooling fluid which is permitted to flow towards or along at least a part of a surface of the inlet end portion 14 which faces away from the combustion chamber 5. According to the invention, the compressor medium defines said cooling fluid. According to one embodiment, disclosed in Fig 2, the cooling fluid for cooling of the inlet end portion 14 is compressor air which via the space 10 is conveyed to and directed towards the inlet end portion 14 for cooling thereof. The combustion chamber device 4 thereby comprises means 16, 17 for conveying the cooling fluid from the space 10 to the inlet end portion 14. It is to be noted here that the inlet end portion 14 is shielded off from the space 10 by a shielding member 18 which encloses and thereby defines the space 15. The conveying means 16, 17 comprises openings in the shielding member 18 and conduits via which the cooling fluid is supplied to the surface of the inlet end portion 14 to be cooled.

According to a first embodiment, which is disclosed in Fig 2, the end portion 14 of the wall member 11 has a double wall, i.e. a space 19 is formed between two walls of the end portion 14. Compressor air may be supplied to this space 19 via gap-shaped opening 16 extending through the shielding

member 18. From the space 19, cooling fluid is supplied to the collecting space 15 via a channel 20 in order to be supplied finally to the burner member 6. The cooling fluid, i.e. the compressor air flowing through the space 19, will thus contribute to the cooling of the end portion 14.

The inlet end portion 14 comprises in this embodiment an inner wall 21 adjacent the combustion chamber and an outer wall 22. The inner wall 21 defines together with the inner wall portion 12 and the outer wall portion 13 the combustion chamber 5. This inner wall 21 needs cooling. It may, in this case, have an annular shape and comprises the inlet openings 7. Furthermore, in each inlet opening 7 a sleeve 23 is arranged to receive a respective burner member 6. The sleeve 23 is at its outer periphery attached to the inner periphery of the inlet opening 7. About each inlet opening a ring 24 is provided on the side of the inner wall 21 which faces a way from the combustion chamber 5. The ring is provided with radial holes 25 through which the cooling fluid, i.e. the compressor air, may flow in a direction towards the sleeve 23.

Furthermore, the combustion chamber device comprises a member 26, which together with an outer surface of the inner wall 21 of the inlet end portion 14 defines a gap 27, into which cooling fluid is conveyed in order to cool the inner wall 21 of the inlet end portion 14. Thus, this gap 27 is a part of the space 19, which is delimited by the delimiting member 26. The member 26 comprises a sheet, provided essentially opposite to and in parallel with the outer surface of the inner wall 21 of the inlet end portion 14 to be cooled by the cooling fluid. The sheet 26 has a plurality of holes 28, which are arranged to convey the cooling fluid through the sheet 26 in a direction towards the outer surface of the inner wall 21 of the inlet end portion 14 to be cooled. The sheet 26 is annular and provided with openings 29. The sheet

26 is arranged to be supported by the rings 24. At its inner and outer periphery, the sheet 26 abuts projections 30 projecting from the inlet end portion 14. Thanks to the provision of the gap 27 and the holes 28 a so-called impingement cooling of the inner wall 21 is obtained.

The sleeve 23 extends from the combustion chamber and is at its end directed from the combustion chamber 5 provided with a radially projecting flange 31. A plurality of axial holes 32 are provided in the flange 31. Between the flange 31 and the sheet 26, a ring member 33, forming a part of the outer wall 22, is provided in such a manner that an annular space is formed between the outer wall 22 and the sleeve 23. The end portion of the outer wall 22 is provided essentially opposite to and is supported by the ring member 33. The ring member 33 is supported via the sheet 26 by the ring 24. Together with the radial holes 25, the holes 28 in the sheet 26 and the openings 32 in the flange 31, said space defines the channels 20, via which the cooling fluid/compressor air may be conveyed to the gas collecting space 15. In such a manner, the cooling fluid from the space 10 flows via the openings 16 and the space 19 through the holes 28 in the sheet 26 to the gap 27 in such a manner that the inner wall 21 is cooled. From the gap 27, the cooling fluid flows through the holes 25 in the ring 26 and the annular gap between the sleeve 23 and the ring member 33 through the channels 20 out into the collecting chamber 15, where it is mixed with cooling air from the wall portion 12 and 13 before it flows into the combustion chamber 5 via the burner 6.

The inner wall 21 of the inlet end portion 14 is formed by a metal sheet of a temperature resistant type. Furthermore, the metal sheet is covered by a heat resistant material, preferably a ceramic layer, on the inner side, i.e. the side

facing the combustion chamber 5. The ceramic layer covers substantially the whole inner side of the inner wall 21.

An alternative embodiment of the combustion chamber device according to the invention is disclosed in Fig 4. The inlet end portion 14 comprises in this case a simple wall 34 which extends between the inner wall portion 12 and the outer wall portion 13 of the combustion chamber. The inlet end portion 14 is also in this case annular and comprises a number of openings 7 for receiving a plurality of burner members 6. As to the rest the inlet end portion is essentially free from openings and thereby arranged not to convey any cooling fluid directly into the combustion chamber 5 but only permit air used for cooling of the inlet end portion 14 to be conveyed into the combustion chamber 5 via the burner members 6. A sheet 35 is provided opposite to and in parallel with a portion of the wall 34. The sheet 35 forms together with a number of further sheets 36 - 38 an annular space into which a cooling medium, in this case cooling air, is conveyed via a conduit means 17, 39 comprising one or several pipes 39 extending from the space 10 to an area of said sheet 35. The sheet 35 is as well as the sheet 26 provided with a plurality of smaller holes 28 at an area thereof facing the wall 34. Via these holes 28 impingement cooling of the wall 34 is obtained. The embodiment is arranged to ensure that only direct high pressure air from the compressor 2 is used for said cooling, i.e. air which has not been previously used for any other cooling purpose.

In the area around each burner member 6, the wall 34 is engaging said burner member 6. The sheet 35 is provided at a distance from the wall 34 in such a manner that a gap 27 is formed therebetween, and the air used for cooling of the wall may flow via the gap 27 and a channel 40 between the annular space and the sheet 35 into the collecting space 15. At opposite ends of the sheet 35, facing away from the

burner members 6, the sheet 35 or a portion 41 connected thereto is arranged to abut the wall 34 in a supporting and possibly sealing manner.

The invention is not limited to the embodiments described above but may be varied and modified within the scope of the following claims.

Claims

1. A combustion chamber device for a gas turbine, comprising a wall member (11) which defines a combustion chamber (5) having an inlet end and an outlet end, wherein the wall member (11) comprises an inlet end portion (14) which has at least one opening (7) for receiving a burner member (6), arranged to generate a flame in the combustion chamber (5), and means (16, 17, 19, 39) for conveying a cooling fluid outside the combustion chamber to the inlet end portion (14) of the wall member (11) for cooling thereof, characterized in that the inlet end portion (14) is substantially closed and defines a barrier against penetration of the cooling fluid into the combustion chamber (5) except through the burner member (6).

2. A combustion chamber device according to claim 1, characterized in that the combustion chamber (5) has a substantially annular shape and is arranged to extend around a rotary axis (x) of a rotor (42) of said gas turbine.

3. A combustion chamber device according to claim 1 or 2, characterized in that the wall member (11) comprises a first, inner wall portion (12), which is arranged to extend around the rotary axis (x), and a second, outer wall portion (13), which is arranged to extend around the rotary axis (x), wherein the inlet end portion (14) comprises an annular wall (21, 34), which extends around the rotary axis (x) close to the combustion chamber and connects the first and second wall portion (12 and 13, respectively).

4. A combustion chamber device according to claim 3, characterized in that it comprises a space (15) for collecting gas to be supplied to the burner member (6) and a channel (20, 40) arranged to convey the cooling fluid used for the

cooling of the wall (21, 34) of the inlet end portion to said space (15).

5. A combustion chamber device according to claim 4, <u>characterized in</u> that it comprises a member (26, 35) which together with an outer surface of the wall (21, 34) of the inlet end portion (14) defines a gap (27), into which a cooling fluid is conveyed for cooling the wall (21) of the inlet end portion (14) and from which the cooling fluid is conveyed via said channel (20, 40).

6. A combustion chamber device according to claim 5, <u>characterized in</u> that the member (26, 35) comprises a sheet, provided essentially opposite to and in parallel with the outer surface of the wall (21, 34) of the inlet end portion (14) to be cooled by the cooling fluid.

7. A combustion chamber device according to claim 6, <u>characterized in</u> that the sheet (26, 35) has a plurality of holes, arranged to convey the cooling fluid through the sheet (26, 35) in a direction towards the outer surface of the wall (21, 34) of the inlet end portion (14) to be cooled by the cooling fluid.

8. A combustion chamber device according to one or several of the preceding claims, <u>characterized in</u> that it comprises a plurality of burner members (6), and that the inlet end portion (14) comprises a plurality of openings (7), which are distributed around the rotary axis (x) and which each is arranged to receive a respective burner member (6).

9. A combustion chamber device according to any one of the preceding claims, <u>characterized in</u> that the cooling fluid comprises an oxygen-containing gas intended to be supplied to the burner member (6).

10. A combustion chamber device according to any one of claims 3 - 9, <u>characterized in</u> that the wall (21, 34) of the inlet end portion (14) comprises a metal sheet which is covered by a ceramic layer on the side which faces the combustion chamber (5).

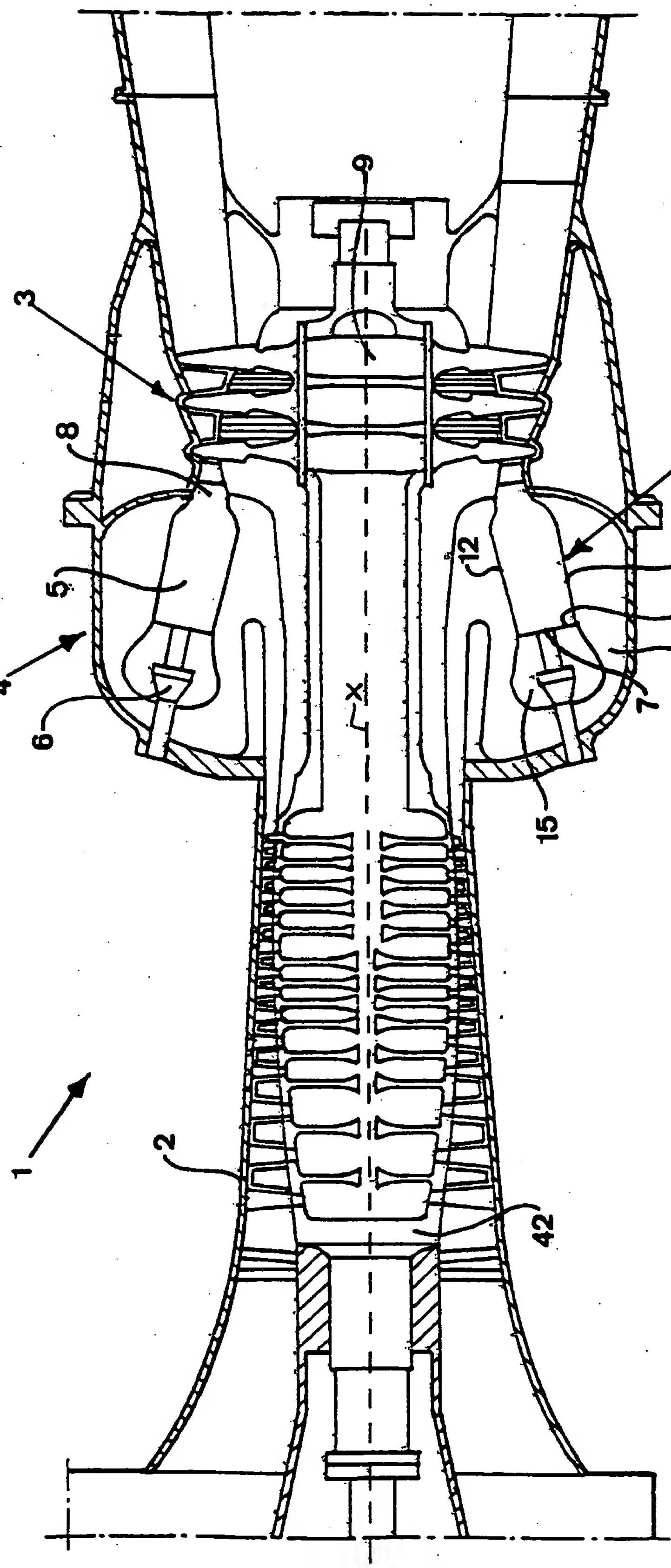


Fig 1

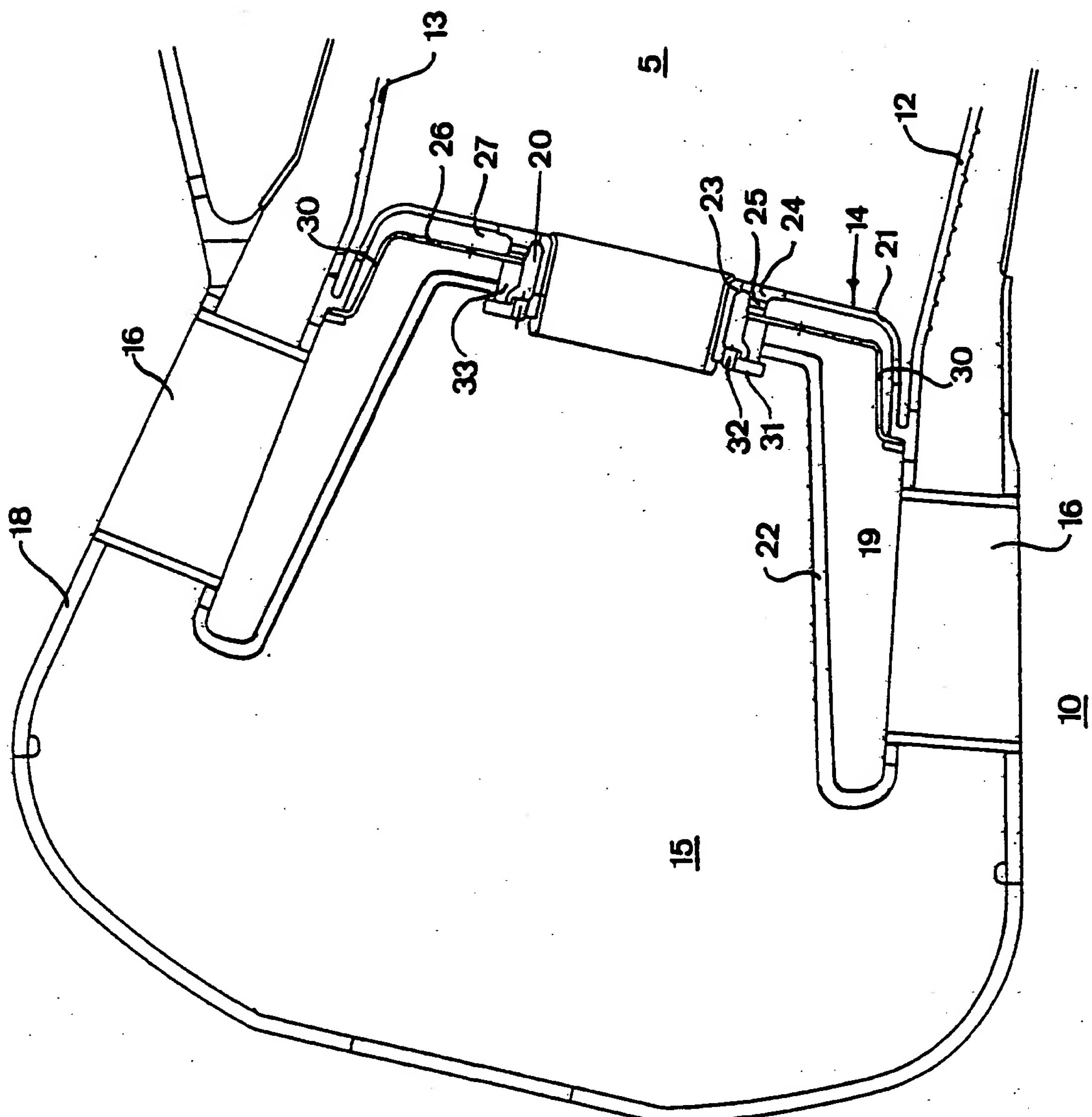


Fig 2

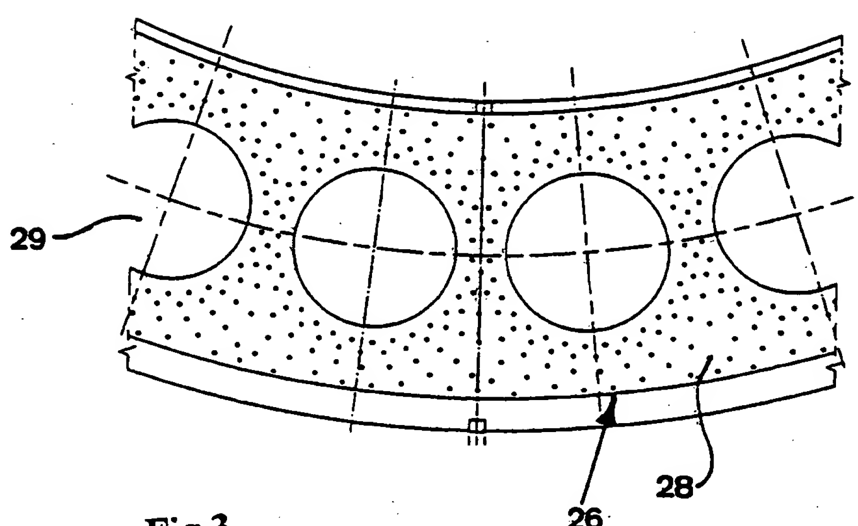


Fig 3

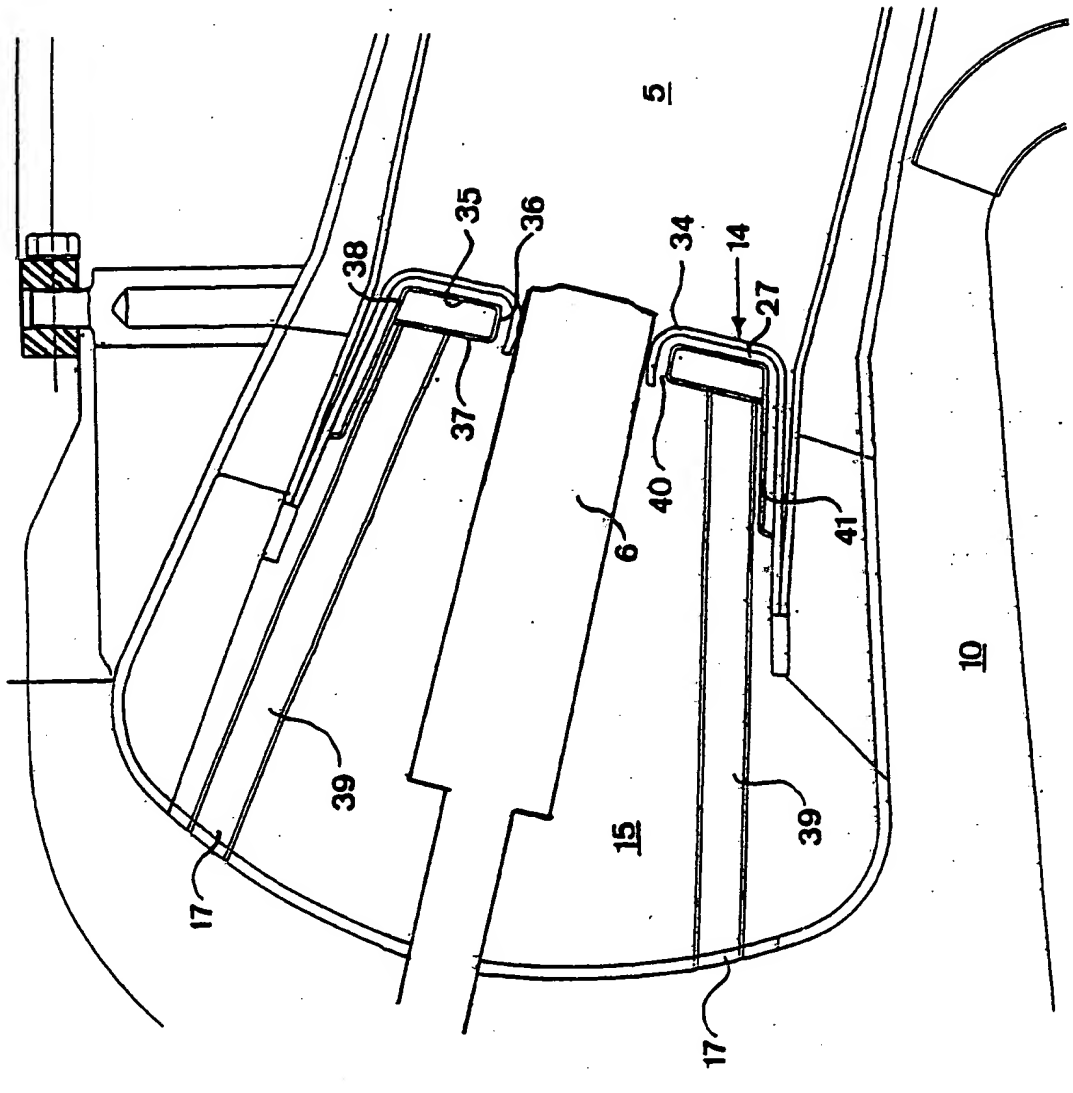


Fig 4

INTERNATIONAL SEARCH REPORT

International application No.
PCT/SE 99/00862

A. CLASSIFICATION OF SUBJECT MATTER

IPC6: F23R 3/10, F23R 3/50, F23R 3/54
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC6: F23D, F23M, F23R

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

SE,DK,FI,NO classes as above

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	DE 4444961 A1 (MTU MOTOREN- UND TURBINEN-UNION MüNCHEN GMBH), 20 June 1996 (20.06.96), figures 1, 2 --	1-10
X	US 5209066 A (BARBIER ET AL), 11 May 1993 (11.05.93), column 2, line 63 - column 3, line 7, figure 1 --	1-3,8-10
X	EP 0780638 A2 (MTU MOTOREN- UND TURBINEN-UNION MüNCHEN GMBH), 25 June 1997 (25.06.97), figures 1-3 --	1-3,8-10
A	US 4843825 A (CLARK), 4 July 1989 (04.07.89) --	

☐ Further documents are listed in the continuation of Box C. ☒ See patent family annex.

* Special categories of cited documents:
"A" document defining the general state of the art which is not considered to be of particular relevance
"E" erlier document but published on or after the international filing date
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
"O" document referring to an oral disclosure, use, exhibition or other means
"P" document published prior to the international filing date but later than the priority date claimed
"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"X" document of particular relevance: the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"Y" document of particular relevance: the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
18 August 1999	29 -09- 1999
Name and mailing address of the ISA/ Swedish Patent Office Box 5055, S-102 42 STOCKHOLM Facsimile No. +46 8 666 02 86	Authorized officer Anders Bruun / MR Telephone No. +46 8 782 25 00

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/SE 99/00862

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
DE 4444961 A1	20/06/96	FR 2728330 A	21/06/96
		GB 2296084 A,B	19/06/96
		GB 9523579 D	00/00/00
		JP 8232685 A	10/09/96
		US 5765376 A	16/06/98
US 5209066 A	11/05/93	DE 69107188 D,T	22/06/95
		EP 0491625 A,B	24/06/92
		FR 2670869 A,B	26/06/92
EP 0780638 A2	25/06/97	DE 19547703 A,C	03/07/97
US 4843825 A	04/07/89	NONE	